# SOME PROJECTS GUIDED (OR BEING GUIDED)

# ON TESTING OF HUMAN BODY

by

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## Background

Computer modeling of the human body is done in many applications including crash analysis and estimation of injury. For rigid body simulations of crashes a number of human body models have been developed and are available with most commercial crash modeling software [PamCrash$^{TM}$], [Madymo$^{TM}$]. At IIT Delhi we have been doing extensive modeling of crashes and have used many of these dummy models. For Finite Element (FE) modeling of crashes, FE dummy models and FE ARB (Articulated Rigid Body) models are extensively used. However, recently need for FE human body models has been felt for a precise prediction of the human body behaviour in crashes. Such models are being developed by many across the world. This requires a detailed modeling of the geometry of the human body. In addition extensive tissue and bone properties beyond those already available in literature are needed.

At IIT Delhi we have been doing extensive work in FE based simulations of vehicle crashes. Our stress has been on modeling crash situations especially relevant to the vulnerable road users including the pedestrians, bicyclists, two wheeler riders and the three-wheeled vehicles. This is because accidents involving this group of road users are particularly important for the Indian context. Till late, the study of crashworthiness issues for the VRUs has not been of interest to most of the researchers in this area. Modeling of crashes involving the VRUs highlights the need of human body models specially designed for these situations. Such models need a greater emphasis on the lower leg models.

Since, attempts to develop FE models for the human body are relatively new, data available for the human body is still not comprehensive. The most comprehensive human body models available are also incomplete in the constitutive properties of the body parts. This is primarily because most of the data collected for the human body in the past has been regarding the behaviour of the body and not regarding the constitutive properties of the human body. Both

the Thums and the H-models have thus used available properties of the tissues and tried to achieve the body behaviour measured by other researchers. The constitutive properties they use are the tensile properties of the bones and the soft tissues, which have been reported by many. However the dynamic properties of the human body tissues under impact conditions are not available in literature. Further, variations in these properties with age, especially for children, is also an open issue.

In this work we propose to develop testing rigs for testing the impact properties of the soft tissues. Additionally, at the St Stephen's Hospital, we plan to collect some samples of human body parts. These samples will be available as and when amputations are carried out in the hospital. The testing rigs developed at IIT will be customized testing rigs to characterize these samples and to determine the constitutive properties. In the initial phase, samples will be collected and preserved in the frozen state for subsequent testing. These tests will give us data, which we will use for estimating the constitutive dynamic properties of the human tissue. The test conditions will be simulated using FE simulations and the dynamic properties will be estimated so as to match the results of the experiment.

## Project 1

### Title:

Validation of Human Neck Finite Element Model Under Different impact conditions

### Description:

In the present work Human Cervical Spine (Neck) Finite Element Model is to be validated for different Impact conditions. The Thums™ Human Body model under PamCrash™ will be used for this purpose. Simulations will be developed for different impact configurations and validated against experimental data already available in literature.

## Project 2

### Title:

Design and Fabrication of a Test Rig for Three Point Quasi-static Bending of Human Ribs with an objective of extracting its mechanical properties.

### Description:

In this work a Test Rig is to be fabricated for conducting Quasi Static Bending test on Human rib in controlled environment. The objective of the test is to obtain the mechanical properties of the ribs. It is proposed to develop a test rig in which the rib will be loaded at slow speeds in the range of 0.1 to 1mm per minute till failure. The forces and the deformations in the rib will be recorded and the mechanical properties of the rib will be extracted from the data obtained.

## Project 3

### Title

Reconstruction of of road accidents

### Description

The need for “Accident reconstruction “is to know the cause of accidents so as to enhance and modify the designs of automobiles to cater to the growing demand of safe transportation. This is important from the point of view of saving precious human life. Such work is very common in other countries from litigation and insurance claim perspectives but has not been started in India as yet. In this work we will be collecting data on accidents on Delhi roads and using the same to reconstruct the accident. The steps we will follow will be as follows.

1. Collection of data regarding road accidents to serve as inputs towards simulation of the accident .The data collected is based on reports like police report, medical report, interview of victims and other relevant data.
2. With the help of the computer software and the data collected / recorded, a model will be generated to reconstruct the accident and analyze the various causes behind the accident.

## Project 4

### Title

Determination of mechanical properties of soft tissues using PHANTOM device

### Description

This project involves use of a Phantom device to estimate the material properties of soft tissues. In this an indentation will be created by a PHANTOM device on soft human body tissues. The Phantom will be programmed to measure the value of the resisting force and the deformation of tissue during the indentation with the stylus. With the help of these two quantities (Force and deformation) a suitable relation will be established and properties of the soft tissue will be extracted using a process of inverse mapping.

## Project 5

### Title

Validation of Human body Finite Element Models.

### Description:

A lot of work has been done in the field of finite element modeling of human body parts and a total human model for safety (THUMS) is the latest in use, but the need to validate these models against experimental data still remains. The THUMS model is partially validated.

Similarly there are other finite element models of human body available.

Experiments/tests conducted on human body parts provide measured data about the response of the same under certain test conditions. These tests can be simulated in sophisticated software packages using finite element models of the human body parts and the testing equipment. Hence the finite element models of the human part are validated when experimental results match the results of simulation.

The thesis work relates to the validation of human knee FE model against test results with the aim of finding out its appropriate mechanical properties.

The software package used for simulation will be Pam crash. The response obtained from the simulation results in Pam crash will be compared with the results obtained from tests.

## Project 6

### Title

To conduct a dynamic tensile test on human ligaments with the aim of estimating the mechanical properties of the same.

### Description

A ligament is a slippery fibrous structure, which joins a bone to another bone at a joint in body. Its primary function is to hold the bones together and to constrain their relative motion.

The work being done involves design of a testing rig for tensile testing of ligaments under dynamic loading conditions. The responses obtained from the test are used to estimate mechanical properties of ligaments.

## Project 7

### Title:

Design and Fabrication of a Quasi static tensile testing machine for testing human ligaments

### Description:

In this work a tensile testing machine is to be fabricated for conducting Quasi Static tensile test on ligament in controlled environment. The objective of the test is to obtain the mechanical properties of the ligament. It is proposed to develop a tensile test in which the ligament will be loaded at slow speeds in the range of 0.1 to 1mm per minute till failure. The forces and the deformations in the ligament will be recorded and the mechanical properties of the ligament will be extracted from the data obtained.